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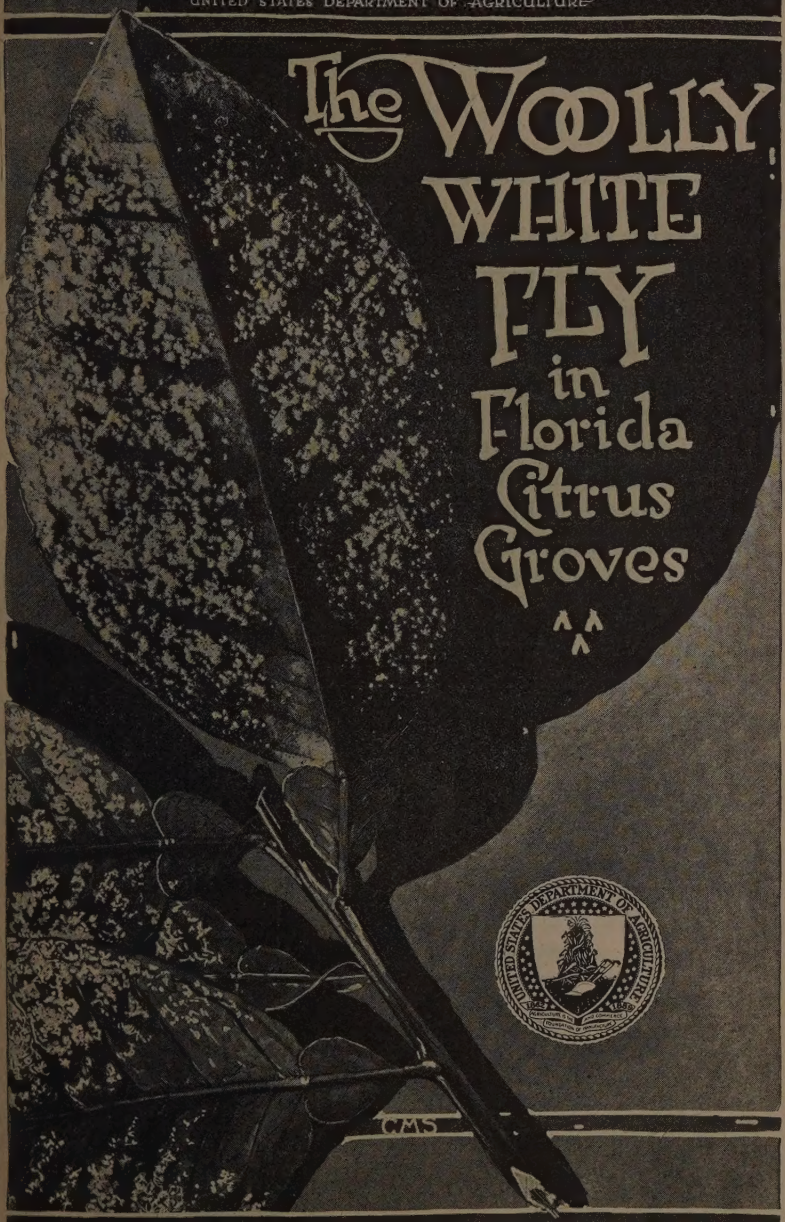
UNITED STATES DEPARTMENT OF AGRICULTURE

The Woolly White Fly in Florida Citrus Groves



THE RAPID SPREAD of the woolly white fly over a greater portion of the citrus-producing sections of Florida has caused some alarm among the owners of orange groves. This bulletin contains information regarding the introduction of the woolly white fly into the United States and its subsequent spread. It shows the grower how to distinguish this pest from all other white flies attacking citrus in Florida, gives a general outline of its life history, tells something about its natural enemies, which usually control it, and describes the remedial measures to be applied in case the natural enemies do not seem to promise aid in the near future.

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief
Washington, D. C. February, 1919

THE WOOLLY WHITE FLY IN FLORIDA CITRUS GROVES.[1]

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WHAT THE WOOLLY WHITE FLY IS LIKE.

THE WOOLLY WHITE FLY (fig. 1), the most recently introduced of the insect pests of Florida citrus groves, and still comparatively little known, is capable at times of rivaling in destructiveness both the citrus white fly[2] and the cloudy-winged white fly,[3] which have been present in Florida much longer and are causing a great annual loss to Florida and Gulf coast growers.

The woolly white fly is a tiny four-winged insect about one-sixteenth of an inch long, covered with a delicate, snowy-white, waxy secretion which hides the yellow color of the body. As with other insects of the white-fly family, the young, or larvæ, which hatch from the minute, almost dustlike eggs, pass through several stages before becoming winged adults. In all of these stages the insect possesses legs, but can use them only in the first stage. The last immature stage is known as the pupa, or resting stage. Larvæ and pupæ of the woolly white fly are clothed with a dense, wool-like covering (figs. 2 and 3) which has suggested the name by which this species is popularly known. Larvæ, pupæ, and adult flies feed by sucking up sap from the leaves of their host plants.

INTRODUCTION AND SPREAD IN FLORIDA.

Whereas the common citrus and cloudy-winged white flies undoubtedly were introduced from southern Asia, the woolly white fly appears to be a native of the West Indies region and doubtless was brought into Florida from Cuba. This insect was first observed

[1] *Aleurothrixus howardi* (Quaintance); order Hemiptera, suborder Homoptera, family Aleyrodidae.
[2] *Dialeurodes citri* (Ashmead).
[3] *Dialeurodes citrifolii* (Morgan).

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in 1903 in Cuba, and later, in 1905, was found in considerable abundance at Artamisa, Cuba. It is now known to be fairly widespread in Cuba, the Isle of Pines, Porto Rico, Mexico, and parts of Florida.

FIG. 1.—Several adults of the woolly white fly on the underside of an orange leaf. The white wings are held farther apart than are those of either the citrus (fig. 5) or cloudy-winged (fig. 6) white flies.

It was first found in Florida at Miami, in 1900, on sea grape but apparently obtained no general foothold in Florida from this colony. Its appearance as an economic pest in Florida dates from November, 1909, when it was observed heavily infesting orange trees at Tampa. When it was discovered at Tampa it was present in greatest numbers on trees near the Hillsboro River at points where the boats from Cuba and other places docked, and near the depot, indicating its probable introduction by means of cargoes or travelers direct from Cuba. From Tampa it has since spread rapidly throughout Florida and is now well distributed over Hillsboro, Pinellas, Manatee, Polk, De Soto, Orange, Lee, and portions of Palm Beach counties, and doubtless soon will infest all the citrus groves in the State.

HOST PLANTS.

The woolly white fly thrives best on citrus trees and prefers them to others, although it has been found attacking the sea grape, common guava, mango, and a species of rubber tree. It is not numerous enough on any of its hosts, except citrus, to be noticeably injurious. Thus, on Sanibel Island, in 1909, only three specimens were found on one leaf of sea grape during a search of half an hour.

Of citrus trees, grapefruit is the favorite with this insect, the orange comes next in attractiveness, and tangerine, lemon, and kumquat trees are not so generally attacked. The woolly white fly has never been found on any forest tree or shrub.

HOW TO DISTINGUISH THE WOOLLY WHITE FLY FROM THE CITRUS AND CLOUDY-WINGED WHITE FLIES.

The woolly white fly is distinguished at once from all other white flies attacking citrus trees in Florida at the present time by the dense white, wool-like covering that develops from the back and sides of the immature stages. This woolly covering, which may be from one-eighth to one-fourth of an inch thick, develops upon the larvæ and pupæ of the white fly and has a protective effect. It causes the underside of badly infested leaves to appear covered with white down. Neither the citrus white fly (see fig. 7) nor the cloudy-winged white fly produces wool-like secretions; in fact, these two species are so transparent that the immature stages are very inconspicuous. There are also differences, although less pronounced, between the adults and eggs of all of these white flies. Neither of the other citrus white flies lays its eggs in circles (fig. 4) as does the female of the woolly white fly. Then, too, the adult of the woolly white fly does not fold its wings so closely over its back. (Compare fig. 1 with figs. 5 and 6.)

FIG. 2.—A pupa case of the woolly white fly, greatly enlarged, to show the white, wool-like secretions covering the insect itself. This heavy covering makes effective spraying difficult. (Watson.)

SECRETION OF HONEYDEW AND GROWTH OF SOOTY MOLD.

Although the larvæ and pupæ of the woolly white fly secrete large quantities of honeydew, sooty mold does not grow so freely on this honeydew as on that secreted by the citrus and cloudy-

FIG. 3.—Orange leaf infested with the woolly white fly.

winged white flies. It is not thrown out to fall upon the upper surfaces of the leaves below unless the flies, larvæ, and pupæ are very abundant, but collects in large globules or drops, as illustrated in figure 8, in the woolly covering of the insect. These drops often become one-eighth of an inch in diameter and may be so numerous as to cause the leaves and even the smaller branches to droop slightly under their weight. When a branch infested by this white fly is jarred sharply, the drops of honeydew fall in a shower, and in badly infested groves the accumulation of honeydew makes the leaves and branches very sticky. This stickiness causes much annoyance to orange pickers and to men and mules engaged in cultural work. It has about the same effect upon the hair and clothing as molasses. In older colonies these drops of honeydew become overgrown with a fungus that makes them appear olive-green or black.

FIG. 4.—Grapefruit leaf showing eggs of the woolly white fly appearing as particles of dust on the underside. Many of them are laid in circles. No other white flies attacking citrus trees in Florida lay their eggs in circles. About natural size. (Back.)

SEASONAL ACTIVITY.

The seasonal activity of the woolly white fly, like that of the other white flies in Florida, has a bearing upon control measures. This pest has four generations a year. Adults are present in the greatest numbers on the trees during four periods: (1) December and January, (2) the latter part of May,

(3) the latter part of July, and (4) October and November. The fall brood coincides very closely with that of the cloudy-winged white fly. During the summer a generation may mature in from 10 to 11 weeks.

When infestation becomes so severe that the trees must be sprayed, the grower should watch closely for the emergence of adults and spray about one week after the flies have disappeared, for by this time the eggs deposited by the females will have largely hatched, and the young larvæ will not yet have developed the thick woolly covering which later will protect them in a large measure from even the most thorough application of spray.

FIG. 5.—Adults of the citrus white fly. These insects have white wings and bodies, are about one-sixteenth of an inch long, and are found upon the underside of leaves of citrus trees, chiefly upon the new growth. They resemble very much the adults of the woolly white fly.

THE WOOLLY WHITE FLY FAVORS SCALE INCREASE.

The presence of the woolly white fly favors the increase of the purple scale.[1] This scale prefers shaded spots. It has been found[2] that the "crawlers," or first-stage larvæ or young of the scale, avoid the light and seek the protection of any substance on the leaf or branches that affords them suitable environment. The woolly covering affords the scale a good place to hide and develop, protected from its natural enemies and from adverse weather conditions such as drenching rains. After the colonies of the woolly white fly have died out numerous purple scales will be found beneath the woolly coverings. Indeed, so characteristic is this gathering of scales beneath the woolly secretions that the white fly can be located on trees

[1] *Lepidosaphes beckii* Newman.

[2] Watson, J. R., Insects of a Citrus Grove. Univ. of Fla. Agr. Exp. Sta. Bul. 148, p. 165–267, 142 fig., June, 1918. (See p. 189.)

by the yellow spots on the leaves caused by the injury of the scales. This, of course, is true only of the older leaves. Trees once infested by the woolly white fly must be watched carefully for some time after the white fly itself has ceased to cause injury, as the purple scale continues to breed in the débris of the old white-fly colonies and there multiplies unhindered, and in the favorable semidarkness of the woolly covering may increase unnoticed to a point where it causes far greater injury than did the white fly.

NATURAL ENEMIES.

Fortunately for the Florida grower, the woolly white fly has a number of natural enemies. The most efficient of these is a tiny wasplike parasite about one-twenty-fifth of an inch long, which lays its egg in the body of the larva or pupa of the white fly. The egg

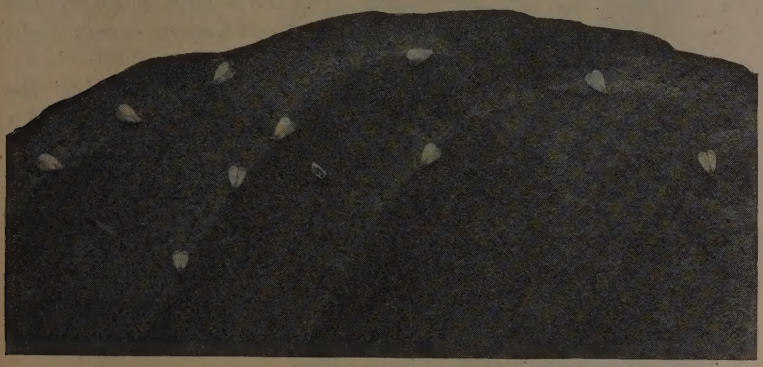


FIG. 6.—Adults of the cloudy-winged white fly, slightly enlarged. The insects are about one-sixteenth of an inch long and have a dark, clouded spot at the tip of the wings. (Morrill and Back.)

hatches into a larva which, as it grows, feeds upon the white fly and kills it, causing it to turn black. When the parasite becomes adult it eats a small round hole in the back of the white-fly pupa, crawls out, and begins to search for other white flies in which to lay its eggs. Parasitized pupæ of this white fly were first observed on Sanibel Island, on sea grape, in 1909, and the parasites were first reared in 1913. Since then this parasite has appeared in all groves in which the woolly white fly is present. Often every white fly upon a leaf will be found with the small round hole in its back, indicating that it was killed by the parasite. It is seldom that this parasite does not effectively check any infestation, no matter how severe it may be, within the course of 3 to 4 months. In fact, so thoroughly does it control the woolly white fly under Florida conditions that it is doubtful whether growers need concern themselves unduly when they discover this pest in their groves.

It is always wise when the woolly white fly appears in a grove for the first time, or appears to be increasing rapidly, to mail a few of the infested leaves in a sealed metal container to the State Experiment Station, Gainesville, Fla., or to the Bureau of Entomology, Washington, D. C., so that the presence or absence of the parasite may be determined, and, if absent, arrangements may be made to colonize it artificially.

FIG. 7.—Leaf of orange the underside of which is heavily infested with the larvæ, pupæ, and pupa cases of the citrus white fly. The immature stages are difficult to see. There are about 800 on this leaf. This species lacks the dense, woolly covering that characterizes the woolly white fly. (Morrill and Back.)

Both the red fungus and the brown fungus which are parasitic on the citrus white fly have been found attacking the woolly white fly, but the good they do is very slight in most instances.

A large number of the woolly white flies die for some reason not yet determined, and a tortricid moth has been seen killing out colonies of the pest in both Cuba and Florida.

ARTIFICIAL METHODS OF CONTROL.

If in any locality parasites do not seem to promise aid in the near future and the pest is spreading rapidly, it may be advisable to spray to check the increase until the parasites become effective. It is best to spray when the white fly is young and before the larvæ have developed their protective woolly covering. The proper spraying period is about a week or ten days after a majority of the adults of any generation have ceased to fly.

Any of the sprays of value in the control of either of the other citrus white flies, or of the scale insects infesting citrus, are effective in checking the woolly white fly. The oil emulsions recommended by this department, however, have been found most satisfactory. These

have a base of cheap lubricating oil, or what may also be called paraffin oil, and may be made into emulsions according to the following formula:

Cold-stirred emulsion.

Fish-oil soap	pounds	6 to 8
Paraffin oil	gallons	2
Water	gallon	1

Directions for preparation.—In preparing the stock mixture, the soap should be put into a receptacle of about 5 gallons capacity. The oil should then be added slowly while the mixture is being stirred. It is important that the oil be added in small quantities at first and also that the stirring be sufficient to keep the oil and soap in the form of an emulsion after each addition of oil. Thus at first about a pint should be added to the soap and the mixture stirred until no free oil appears. As the amount of oil is increased, it should always be stirred or mixed thoroughly before the next addition is made. After the required amount of oil has been added, and all free oil has disappeared from the top of the mixture, water is poured in slowly, about a quart at a time. The only implements required to make this formula in small quantities are an ordinary pail and a paddle. By adding 1 gallon of this stock solution to 50 gallons of water a spray solution is formed containing about 1 per cent of oil. This is sufficiently strong to kill white flies.

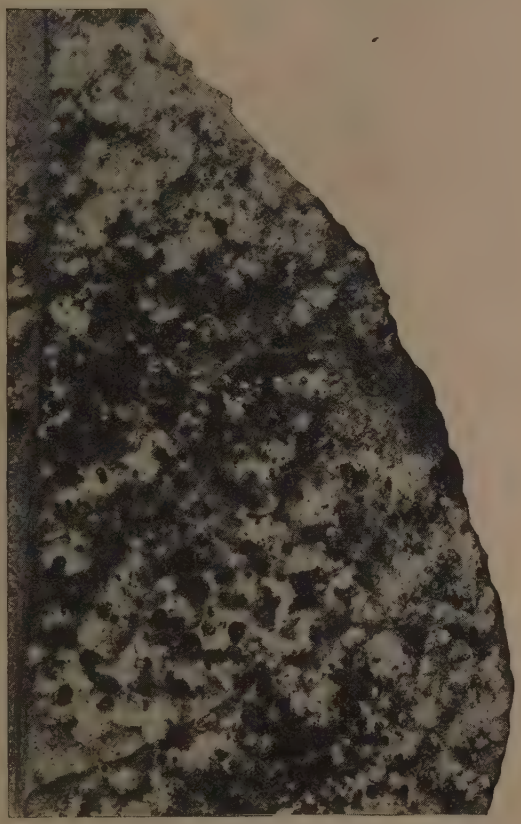


FIG. 8.—Section of grapefruit leaf showing the drops of honeydew caught in the woolly secretions. Many of these larvæ become black owing to the growth of a fungus known as sooty mold. (Back.)

Many alterations may be made in the foregoing formula. The quantity of soap required will depend largely upon the time consumed in adding the oil and the amount of stirring accompanying this

process. The amount of soap is lessened if the stirring is uniform and if ample time is taken in the preparation.

If it is desired that this spray solution be made on a large scale, that the boiled formula, which costs somewhat less, be used, or that hard instead of lake water be employed, application should be made to the U. S. Department of Agriculture for Farmers' Bulletin 933, which discusses more fully spray mixtures for white flies and scale insects.

SUMMARY.

(1) The woolly white fly, while not usually so injurious to citrus trees as either the citrus white fly or the cloudy-winged white fly, may be exceedingly injurious at times. Like them it is an introduced pest. Indications are that it was introduced into Florida from Cuba, and that it first secured a permanent foothold at Tampa.

(2) The woolly white fly is at once distinguished from all other white flies attacking citrus trees in Florida by the dense, white, wool-like covering that develops from the back and sides of the immature stages. The immature stages of both the citrus white fly and the cloudy-winged white fly, on the other hand, are almost transparent and do not produce wool-like secretions. Many of the eggs of the woolly white fly are laid in circles, which is not the case with any other known white fly on citrus.

(3) This pest favors the increase of the purple scale. The young of this scale find a most favorable location for development in the wool-like secretions that follow infestation by this fly. Trees that have had a heavy infestation of the woolly white fly should be watched carefully for the purple scale, so that the proper remedial measures may be taken if much damage from the latter threatens.

(4) The woolly white fly is usually controlled by an internal parasite. If the pupæ show small round holes on the back, it is proof that these beneficial insects are present. In case the parasites do not seem to promise aid in the near future and the pest is spreading rapidly, it may be advisable to spray with one of the oil emulsions to assist in preventing any serious damage to the trees. The spray should be applied about a week or ten days after the disappearance of the adults, when a majority of the eggs have hatched and before the immature stages have developed very much of their protective woolly covering. It is very difficult to obtain satisfactory results if the spraying is directed against the pupæ, since the wool-like covering prevents the spray from coming in contact with the body of the insect.

(5) When a grower finds this pest present in his grove, a sample of leaves should be sent in a sealed metal container to either the State Experiment Station, Gainesville, Fla., or the Bureau of Entomology, United States Department of Agriculture, Washington, D. C. An examination of the leaves will determine whether or not the parasite referred to in paragraph 4 is present and what remedial measures, if any, should be taken.

PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE RELATING TO FRUIT INSECTS.

PUBLICATIONS AVAILABLE FOR FREE DISTRIBUTION.

Control of the Citrus Thrips in California and Arizona. (Farmers' Bulletin 674.)

Handling and Shipping Citrus Fruits in the Gulf States. (Farmers' Bulletin 696.)

Citrus Fruit Improvement. (Farmers' Bulletin 794.)

Aphids, Injurious to Orchard Fruits, Currants, Goosberries, and Grapes. (Farmers' Bulletin 804.)

Cranberry Insect Problems and Suggestions for Solving Them. (Farmers' Bulletin 860.)

Information for Fruit Growers About Insecticides, Spraying Apparatus, and Important Insect Pests. (Farmers' Bulletin 908.)

Fumigation of Citrus Trees. (Farmers' Bulletin 923.)

Control of the Argentine Ant in Orange Groves. (Farmers' Bulletin 928.)

Spraying for the Control of Insects and Mites Attacking Citrus Trees in Florida. (Farmers' Bulletin 933.)

The Woolly White Fly in Florida Citrus Groves. (Farmers' Bulletin 1011.)

Citrus Fruit Insects in Mediterranean Countries. (Department Bulletin 134.)

Mulched-basin System of Irrigated Citrus Culture and Its Bearing on Control of Mottle-leaf. (Department Bulletin 499.)

The Mediterranean Fruit Fly in Hawaii. (Department Bulletin 536.)

The Striped Peach Worm. (Department Bulletin 599.)

The Mediterranean Fruit Fly. (Department Bulletin 640.)

Some Reasons for Spraying to Control Insect and Mite Enemies of Citrus Trees in Florida. (Department Bulletin 645.)

The Argentine Ant in Relation to Citrus Groves. (Department Bulletin 647.)

Citrus Fruit Improvement; A Study of Bud Variation in the Marsh Grapefruit. (Department Bulletin 697.)

Orange Thrips, Report of Progress, 1909–1910. (Bureau of Entomology Bulletin 99, Part 1.)

Red-banded Thrips. (Entomology Bulletin 99, Part 2.)

Spraying Experiments Against Grape Leafhopper in Lake Erie Valley in 1911. (Entomology Bulletin 116, Part 1.)

Lime-Sulphur as Stomach Poison for Insects. (Bureau of Entomology Bulletin 116, Part 4.)

Wooly Aphis of Apple. (Bureau of Entomology Circular 20.)

Fruit Tree Bark-Beetle. (Bureau of Entomology Circular 29.)

Apple Maggot or Railroad Worm. (Bureau of Entomology Circular 101.)

How to Control Pear Thrips. (Bureau of Entomology Circular 131.)

Cooperative Work in Eradicating Citrus Canker. (Separate 711, from Yearbook, 1917.)

Danger of Introducting Fruit Flies in the United States. (Separate 731, from Yearbook, 1917.)

Wooly Apple Aphis. (Agricultural Report 101.)

PUBLICATIONS FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C.

Scale Insects and Mites on Citrus Trees. (Farmers' Bulletin 172.) Price, 5 cents.

More Important Insect and Fungous Enemies of Fruit and Foliage of Apple. (Farmers' Bulletin 492.) Price, 5 cents.

Sites, Soils, and Varieties for Citrus Groves in the Gulf States. (Farmers' Bulletin 538.) Price, 5 cents.

Propagation of Citrus Trees in Gulf States. (Farmers' Bulletin 539.) Price, 5 cents.

Culture, Fertilization, and Frost Protection of Citrus Groves in the Gulf States. (Farmers' Bulletin 542.) Price, 5 cents.

Dock False Worm; An Apple Pest. (Department Bulletin 265.) Price, 10 cents.

The Terrapin Scale; An Important Insect Enemy of Peach Orchards. (Department Bulletin 351.) Price, 15 cents.

The Cherry Leaf-Beetle; A Periodically Important Enemy to Cherries. (Department Bulletin 352.) Price, 10 cents.

Apple Leaf-sewer. (Department Bulletin 435.) Price, 5 cents.

The Pear Leaf-worm. (Department Bulletin 438.) Price, 5 cents.

Knot of Citrus Trees Caused by Sphaeropsis Tumefaciens. (Bureau of Plant Industry Bulletin 247.) Price, 15 cents.

Papers on Deciduous Fruit Insects and Insecticides. (Bureau of Entomology Bulletin 68.) Price, 25 cents.

Fumigation for Citrus White Fly as Adapted to Florida Conditions. (Bureau of Entomology Bulletin 76.) Price, 15 cents.

Fumigation Investigations in California. (Bureau of Entomology Bulletin 79.) Price, 15 cents.

Test of Sprays Against European Fruit Lecanium and European Pear Scale. (Bureau of Entomology Bulletin 80, Part 8.) Price, 10 cents.

Paper on Deciduous Fruit Insects and Insecticides. (Bureau of Entomology Bulletin 97.) Price, 25 cents.

Natural Control of White Flies in Florida. (Bureau of Entomology Bulletin 102.) Price, 20 cents.

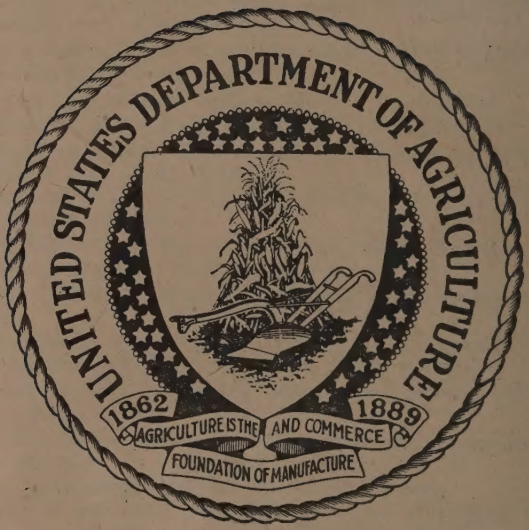
Plum Curculio. (Entomology Bulletin 103.) Price, 50 cents.

Report of Trips to India and The Orient in Search of Natural Enemies of Citrus White Fly. (Bureau of Entomology Bulletin 120.) Price, 15 cents.

Insects Injurious to Citrus Fruits and Methods for Combating Them. (Porto Rico Bulletin 10.) Price, 10 cents.

Citrus Fruits in Hawaii. (Hawaiian Bulletin 9.) Price, 5 cents.

Information About Spraying for Orchard Insects. (Separate 480 from Yearbook, 1908.) Price, 5 cents.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